

## REMARKS

Claims 1–26 were pending in the application prior to entry of this amendment. This amendment adds new claims 27–30.

### The Examiner Interview

The undersigned would like to thank the Examiner for the courtesy of a telephone interview of March 4, 2009. In this interview, U.S. 5,849,215 (Bartlett et al.) was discussed with respect to the independent claims.

### The Amendments to the Claims

Claim 6 has been amended to specify that the flux is of an aqueous solution. This amendment is supported at page 9, line 19 of the application as filed.

Claim 21 has been amended to specify the method, rather than the membrane, of claim 12 thereby improving the antecedent basis.

Claim 24 has been amended to specify that the pore structure of the LLC polymer porous membrane has hexagonally ordered, cylindrical nanopores or interconnected, ordered, 3-D nanopores. This amendment is supported by original claims 1 and 8.

New claim 27 depends from claim 1 and specifies that the LLC polymer is formed of polymerized LLC monomers in an ordered assembly and an optional crosslinking agent and the LLC monomers form the inverted hexagonal phase. New claim 27 is supported at page 5, lines 4-5, page 5, line 21 through page 6, line 2, and page 10, lines 5-8.

New claim 28 depends from claim 1 and specifies that the LLC polymer penetrates into the pores of the support. This limitation is supported at page 7, ll. 26–27 of the application as filed.

New claim 29 depends from claim 8 and specifies that the LLC polymer is formed of polymerized LLC monomers in an ordered assembly and an optional crosslinking agent

and the LLC monomers form a bicontinuous cubic phase. New claim 29 is supported at page 5, lines 4-5 and page 6, lines 4-9, and page 10, lines 5-8.

New claim 30 depends from claim 8 and specifies that the LLC polymer penetrates into the pores of the support. This limitation is supported at page 7, ll. 26-27 of the application as filed.

No new matter has been added with any amendment.

#### The Rejection Under 35 U.S.C. 102(b)

Claims 1-11 and 24-26 were rejected under 35 U.S.C. 102(b) as anticipated by, or in the alternative, under 35 103(a) as obvious over Bartlett et al. (US 6,503,382, hereinafter '382).

Claims 1 and 8 and amended claim 24 all relate to a lyotropic liquid crystal (LLC) polymer porous membrane attached to a porous support, wherein the pore structure of the LLC polymer porous membrane has hexagonally ordered, cylindrical nanopores (claims 1 and 24) or interconnected, ordered, 3-D nanopores (claims 8 and 24). **As described in the specification, a LLC polymer is formed of polymerized LLC monomers in an ordered assembly (page 5, ll. 4-5) and may contain an optional cross-linking agent (page 10, ll. 5-8).** LLC monomers are polymerizable amphiphilic molecules containing one or more hydrophobic tails and a hydrophilic headgroup (page 5, ll. 5-9).

An LLC polymer network with a pore structure of hexagonally ordered, cylindrical nanopores can be formed through cross-linking of polymerizable LLC monomers which form the inverted hexagonal LLC phase in the presence of water (page 5, ll. 21-30). As shown in Figure 1 of the present application, the inverted hexagonal ( $H_{II}$ ) phase takes the form of generally cylindrical inverted micelles having an aqueous core, the inverted micelles having a hexagonal arrangement. The hydrophobic tails extend outward from the aqueous cores to form organic domains. Photopolymerization or photo-cross-linking

of the hydrophobic tails results in the formation of a polymer network containing hexagonally ordered, cylindrical water-filled nanopores. Similarly, an LLC polymer network with a pore structure of interconnected, ordered, 3-D nanopores can be formed through cross-linking of polymerizable LLC monomers which form a bicontinuous cubic LLC phase in the presence of water (page 6, II. 5–9).

In an embodiment of the present invention, the LLC polymer membrane is formed *in situ via direct polymerization of the LLC monomers* on at least a part of the surface of the porous support, and the attachment between the membrane and the support is made during the membrane fabrication process (claims 12, 22, and 23 and page 7, 16–19). *In situ* formation of the LLC membrane is preferred for membranes thin enough that the membranes would be expected to tear during transfer of the membrane. It is expected that the polymer membrane thicknesses of interest for the present invention would be susceptible to tearing when peeled from a substrate (page, 7, II, 19–23).

The '382 patent describes methods of preparing a porous film involving electrodeposition of a material from a deposition mixture onto a substrate. The deposition mixture comprises a source material for the film, dissolved in a solvent, and a sufficient amount of an organic structure-directing agent to provide a homogeneous LLC phase for the mixture (col. 2, II. 1–5, and 24–30). An amphiphilic organic compound or compounds may be used as the structure directing agent (col. 4, II. 26–27). Suitable substrates include electrically conductive materials such as polished gold, copper or carbon electrodes (col. 5, lines 14–16); no teaching is provided that these substrates are porous.

The '382 reference states that by controlling the nanostructure of the LLC phase and electrodepositing, a film may be synthesized having a corresponding templated nanostructure (col. 4, II. 9–14). As described at col. 4, II. 14-16, the film structure appears to result from electrodeposition around the assembled structure directing agent. Col. 4, II. 14-16 gives an example of films deposited from normal topology hexagonal phases, stating that the films deposited from normal topology phases will

have a system of pores disposed on a hexagonal lattice. In contrast to the inverted topology phases shown in Figure 1 of the present application, normal topology hexagonal phases take the form of cylindrical micelles having an organic, rather than an aqueous core, the micelles having a hexagonal arrangement (as illustrated in Figure 1 of the DePierro reference submitted with the Information Disclosure Statement of 02/14/08). Since the '382 reference uses a hexagonal arrangement of normal micelles to obtain a system of pores disposed on a hexagonal lattice, the film structure results from a "casting" around the assembled structure-directing agent (i.e., LLC phase-templated synthesis), rather than being formed by direct polymerization of the structure-directing agent (i.e., the LLC molecules), as in the present invention.

The '382 reference does not teach polymerization of the LLC structure-directing agent of the deposition mixture. Applicants further note that in the example given at col. 4, ll. 14–16 of the reference and discussed in the previous paragraph, direct polymerization of the hydrophobic tails of the structure-directing agent is contrary to the teaching of the reference. Polymerization of the hydrophobic tails of the structure-directing agent in a normal topology phase would produce polymerized cylinders of structure-directing agent, rather than the desired polymer film having a system of pores disposed on a hexagonal lattice.

The '382 reference also does not teach electrodeposition of polymer sources which act as LLC structure directing agents. The example given of polymer electrodeposition (Example 8) describes electrodeposition of poly(orthophenylene diamine) from a solution containing o-phenylene diamine (source of the polymer) and octaethylene glycol monododecyl ether (structure-directing agent). No teaching is provided that the source of the polymer is also a structure-directing agent.

In view of all the foregoing, Applicants submit that the '382 reference does not teach polymerization of an amphiphilic structure-directing agent to form a porous polymeric

film of the structure-directing agent having the specified pore geometries of claims 1, 8 and 24 of the present invention.

In view of all the foregoing, Applicants request reconsideration and withdrawal of the rejection of claims 1, 8, and 24. Since claims 2–7 depend from and incorporate all the limitations of claim 1, claims 9–11 depend from and incorporate all the limitations of claim 8, and claims 25–26 depend from and incorporate all the limitations of claim 24, Applicants also request reconsideration and withdrawal of the rejection of claims 2–7, 9–11, and 25–26.

#### The Rejections Under 35 U.S.C. 103(a)

Claims 12-23 were rejected under 35 U.S.C. 103(a) as being unpatentable over Gin et al. (US 5,849,215, hereinafter patent '215) in view of Bartlett et al. ('382).

The Office Action acknowledges that the '215 reference does not teach formation of films or layers on a porous support, but asserts that one skilled in the art at the time the invention was made would have been motivated to provide a support for the structure of patent '215 and further to select a porous support that is porous.

The Office Action also asserts that patent '382 teaches providing LLC layer(s) or films on a support that can be part of the final membrane and formation of a film on a previously formed nanoporous film. As previously discussed, Applicants submit that the '382 reference does not teach formation of a porous LLC polymer film on a support. Applicants also submit that patent '382 does not teach formation of electrodeposited films on a porous support. Applicants note that the '382 reference provides no teaching that the conductive substrate used in the electrodeposition process is porous. The Office Action asserts that a first porous film may be considered a support for subsequent porous films. However, Applicants submit that the first film would be formed upon the non-porous conductive substrate, and so the support material as a whole would not be porous. The non-porous conductive substrate is an essential

element of the electrodeposition process described in the '382 patent and should not be disregarded. In addition, Applicants submit that the first film is not necessarily porous until removal of the structure-directing agent (i.e., LLC phase template), which occurs following electrodeposition as described at col. 5, lines 46–47. In the example described above where the film is “cast” or templated around the structure-directing agent in a normal hexagonal phase, the pores in the film are formed by subsequent removal of the structure-directing agent. Therefore, the film is not porous until electrodeposition is complete. In the present application, the LLC phases of the polymerizable monomers and the directly polymerized LLC phases are intrinsically porous with water present in the LLC nanopores. Applicants submit that no teaching is provided of removal of structure-directing agent between deposition of layers of different species

In view of all the foregoing, the combination of the '215 and '382 references fails to teach all the limitations of claims 12, 22, and 23, all of which specify fabrication of an LLC polymer porous membrane attached to a porous support. Applicants respectfully request reconsideration and withdrawal of the rejection of claims 12, 22, and 23. Since claims 13–21 depend from and incorporate all the limitations of claim 12, Applicants request reconsideration and withdrawal of the rejection of claims 13–21.

#### The Rejection Under 35 U.S.C. 112

Claim 6 was rejected under 35 U.S.C. 112, second paragraph. In particular, the Office Action states that the claim is incomplete regarding the type of flux (gas, liquid, or water). The rejection is believed obviated by the amendment to claim 6. Reconsideration and withdrawal of the rejection is respectfully requested.

#### The New Claims

New claims 27 and 29 depend from claims 1 and 8, respectively and specify that the LLC polymer is formed of polymerized LLC monomers in an ordered assembly and an optional crosslinking agent. New claims 27 and 29 are believed to be patentable over the cited reference in view of their dependence from claims 1 and 8. Following the

previous discussion, the combination of the '215 and '382 references fails to teach fabrication of the LLC polymer porous membrane attached to a porous support, where the LLC polymer is formed of polymerized LLC monomers in an ordered assembly and an optional crosslinking agent.

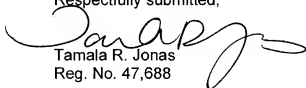
New claims 28 and 30 depend from claims 1 and 8, respectively, and specify that the LLC polymer penetrates into the pores of the support. New claims 28 and 30 are believed to be patentable over the cited reference in view of their dependence from claims 1 and 8. It is also believed that the penetration of the LLC polymer into the pores of the support is not specified in the cited references.

### CONCLUSION

All claims being in condition for allowance, passage to issuance is respectfully requested.

It is believed that a fee of \$659, including \$555 for a 3 month extension of time and a fee of \$104 for the addition of 4 dependent claims is due with this submission. Payment of the filing fees and the surcharge due is being made through the Electronic Filing System in the amount of \$659. If the amount submitted is incorrect, please charge any deficiency or amount for any extension of time required, or credit any overpayment, to Deposit Account No. 07-1969.

Respectfully submitted,



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